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Water Quality Issues facing Indigenous Peoples in North America and Siberia

By

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Abstract

Contaminated water is a worsening problem of global concern that disproportionately affects many Indigenous communities. This study focuses on water-quality issues facing two Indigenous communities – the Altaian people of Central Siberia, and the Prairie Band Potawatomi Nation of Northeastern Kansas. Information was collected about each community's water resources and cultural attitudes towards them through a series of interviews and quantitative water-quality tests. Results revealed similar attitudes and reverence for water resources in both communities, and that both communities have defined protocols for their interactions with water resources. Each community is facing threats to their water quality from different sources of pollution, and may benefit from a community-based water-quality monitoring program to better inform them of their water quality.

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Chapter I

Introduction

Water-related issues are possibly the most important human health and environmental justice concerns facing the human population today, and continue to gain importance internationally. The world is facing a serious water crisis, caused in large part by the global mismanagement of water resources (United Nations, 2003). This problem will continue to deteriorate unless urgent action is taken. The concern about our water resources is so great that former U.N. Secretary General Boutros Boutros Ghali said in 2002 that “water will be more important than oil in this century” (*Talking Points*, 2003).

Water is the most widely-occurring substance on our planet; yet over 95 percent is salt water unsuitable for direct human consumption. Only 2.53 percent of the water on earth is fresh water. Of that small fraction of fresh water, two-thirds is locked in glaciers or permanent snow cover. The relatively small remainder is distributed somewhat unevenly among the continents (United Nations, 2003). The distribution of available fresh water compared to the percentage of the global human population for each continent is shown in figure 1.

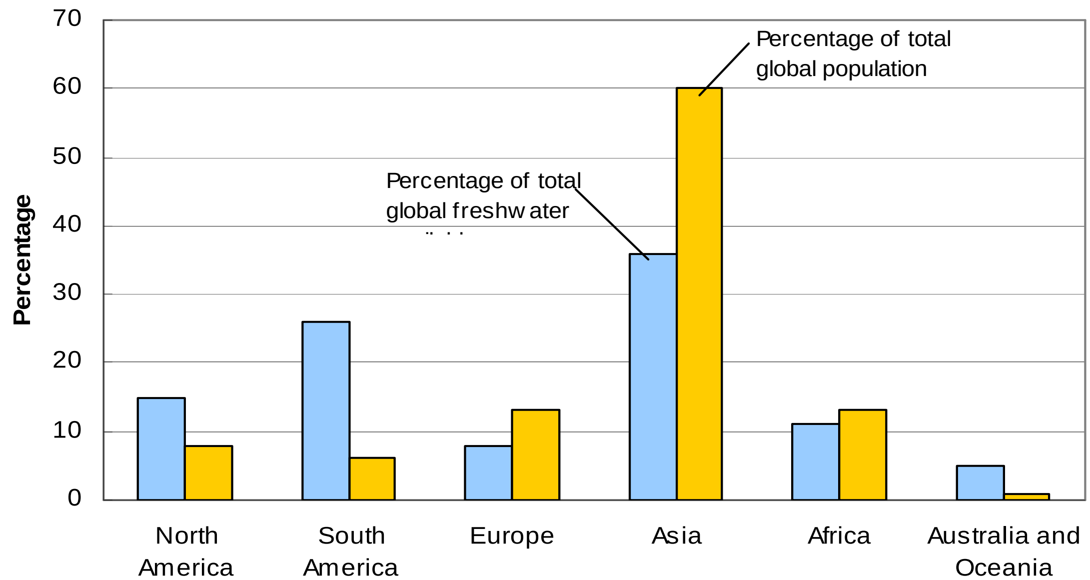

Figure 1. Global w ater availability and human population by continent.
Source: The United Nations World Water Development Report, 2003

Humans all over the world have become significant players in the hydrologic cycle, through their heavy use of water resources and efforts to make appropriation of water more efficient, such as man-made dams and storage reservoirs. Globally, humans withdraw 8 percent of the total annual renewable freshwater and appropriate 26 percent of annual evapotranspiration and 54 percent of accessible runoff (United Nations, 2003). As illustrated above, there are huge disparities in availability in different parts of the world, as well as wide differences in seasonal and annual precipitation depending on geographical location.

Many potential problems surround available water resources, including international conflicts over their use, contamination and pollution, natural disasters and global warming, and scarcity of resources. Several countries today are unable to provide safe, clean drinking water or basic sanitation services to all citizens. As of 2002, 1.1 billion people, or 17 percent of the global population, lacked access to improved water sources; and 2.6 billion people, or 42 percent of the world's population, lacked access to improved sanitation(World Health Organization, 2004). As a result, water-related disease has become a problem of epidemic proportions that is only expected to get worse. By 2025, it is projected that two-thirds of the global population will live in water-stressed countries, defined as countries lacking the infrastructure to provide safe drinking water and adequate sanitation services (Kirby, 2004).

Pollution has reduced the total quantity of available fresh water in many parts of the world, in the form of an estimated 2 million tons of waste that are disposed of in the world's waterways each year. Contaminants include industrial wastes and chemicals, human waste and agricultural wastes (fertilizers, pesticides and pesticide residues). The United Nations reports that 1 liter of wastewater pollutes 8 liters of fresh water, which places the present burden of pollution at up to 12,000 km^3 worldwide (United Nations, 2003). Contaminated water sources lead to serious physical ailments in those who rely upon them for drinking and domestic use. A partial list of possible illnesses includes gastrointestinal illness, eye/nose irritation, central nervous system problems, anemia (caused by Chlorine-based disinfectants in drinking water), cancer, hepatitis, dermatitis, rheumatoid arthritis (caused by heavy metal contamination), Legionnaire's disease (caused by aspiration of water contaminated with *Legionella pneumophila* bacteria), liver or kidney damage and nerve damage (caused by disinfectant byproducts such as Trihalomethanes), overactive thyroid, learning defects and delayed physical or mental development in children (caused by lead in drinking water), hair or fingernail loss (caused by excessive selenium or thallium in drinking water) and infant death ("Ambient student"; ATSDR, 2009; Brechner, Parkhurst, Humble, Brown, & Herman, 2000; Healthopedia, 2009; USEPA, 1999; USEPA, 2009). Perhaps most disturbing is the number of infant deaths caused by preventable water-related diseases. The World Health Organization (WHO) in 2004 estimated that, of the 3.1 million people who die of diarrheal disease (including cholera) or malaria every year, 90 percent are children younger than 5 years of age. The failure to provide safe drinking water and adequate sanitation services to all people has been called "the greatest development failure of the 20th century" (Gleick, 2002).

A disproportionate number of environmental justice issues, including degraded water quality, are burdened by the poor of the world. The United Nations estimates that 50 percent of the population in developing countries is exposed to polluted water sources (United Nations, 2003). Unfortunately, Indigenous populations often fall in this category. Many countries report that their Indigenous People consistently lag behind the rest of the population in monetary income. In a mandate outlining major points to be addressed during the International Decade of the World's Indigenous People, which lasted from 1994 to 2004, the World Health Organization recognized evidence that ethnicity, particularly in conjunction with poverty, contributes strongly to disparities in health between population groups. A study on Indigenous People and poverty in Latin America found that being Indigenous increased an individual's likelihood of being poor, even when controlling for basic factors strongly associated with poverty, such as age, education, employment status and region within a country. The study also found that Indigenous People, especially women and children, continue to have less access to basic health services (Hall and Patrinos, 2005). Monetary poverty and lack of health care greatly exacerbate the effects of contaminated water resources on Indigenous People when compared to non-Indigenous populations.

Organizations around the world have begun to recognize the issues facing Indigenous People and their water resources, and to work toward solutions. The Indigenous Water Initiative is a program of the Center for Respect of Life and the Environment (CRLE) and is dedicated to "understanding and articulating Indigenous perspectives on water and development." The Initiative grew out of the World Water Forum held in Kyoto, Japan in March 2003, where CRLE co-organized several sessions on Indigenous water issues. The Initiative recognizes four water-related challenges faced by Indigenous People: (1) Indigenous cultural and spiritual understandings about water are misunderstood or simply ignored by the dominant Western societies; (2) Indigenous communities are not included meaningfully in water policy and planning processes; (3) Customary access and rights to water is seldom recognized by the state authorities that now control Indigenous areas, and (4) Water bodies that are critical to cultural and physical wellbeing are being polluted by outside forces beyond their control (Indigenous water initiative, 2003). These four points helped to guide the framework for this study.

There are over 300 million Indigenous Peoples living around the world (United Nations, 2003), many of whom wish to continue their traditional life-ways, maintaining closer contact with natural water and other resources than people living in a non-Indigenous manner. As an issue of environmental justice, Indigenous People have the right to continue traditional practices without threats to their health nor their rights to customary resources. Water rights are an increasingly contentious issue for everyone, and particularly so for Indigenous communities whose customary use of water is neither legally recognized nor practically respected.

In the summer of 2004 I had the opportunity to travel to the Altai Republic of Siberia, literally on the other side of the world from Kansas. This was a truly life-changing experience for me in many ways. As my first trip outside of the United States, it was my first immersion experience in a foreign culture, as well as my first experience working on water quality issues. I joined a group that had been working since 2000 to exchange ideas and solutions to water quality issues between Indigenous People from two different continents. We engaged in dialogue with European Russians and Indigenous Altaians about their water resources, and conducted tests of wells, springs, rivers and lakes. The experience inspired me to return to this area over the following two years, in order to continue my investigation of solutions to the problems that face the Altai Republic, its people, and their water supply.

After learning about and experiencing issues involved in water quality issues in Siberia, a logical extension was to investigate water quality issues facing Indigenous communities in Kansas. In 2005, I began volunteering with United States Geological Survey (USGS) on their project with the Prairie Band Potawatomi Nation (PBPN), which led to a paid internship to continue this work. Working with the USGS exposed me to the problems that affect surface and ground water in the Midwest, and simultaneously to some of the problems facing Indigenous People in America who are trying to secure an accessible water supply for their tribe. It was these experiences that helped shape my current research interests, and provided the basis for this study.

The focus of my work is to examine the water quality issues facing the Prairie Band Potawatomi Nation (Kansas, U.S.A.), and the Altai Republic (Russian Federation). These Indigenous communities are facing different issues, but both may serve as examples to our global community. This study involves the use of interviews to determine the attitudes of communities toward their water resources and the feasibility of community-based action to increase awareness of the quality of their water supplies. The goal of this study is to establish criteria for a sustainable community-based water quality monitoring program that will better inform people about their water resources, whether they are used for drinking and domestic use (well-water, tap water), hunting and fishing, or aesthetics and tourism (rivers, lakes, and springs).

In order to obtain the information necessary to meet the goals of this research project, a varied cross-section of people were interviewed to determine the views of each population toward local water bodies, and their willingness to participate in community-based monitoring of their water supplies. This was the best way to determine the general attitudes of the community, as well as the availability of information to that community. These interviews had an added benefit of initiating dialog with people in both communities, which also served to build trust that will better facilitate future research and implementation of a community-based monitoring program.

To compliment the available literature in determining the sources of pollution and the risks facing the communities, I performed water quality tests of ground and surface water in both the Altai Republic and the Prairie Band Potawatomi Nation. This was done with the same test kits that I expect to distribute to communities, so an additional objective was to demonstrate that they are useful tools for examining water quality.

The people whose experiences and opinions are presented here represent a small sample of their communities, and do not have the authority to speak for the entire population. The participants represent both Indigenous and non-Indigenous community members and environmental specialists.

This study is presented in the following four chapters. Chapter II is a review of literature illustrating various ways in which contaminated water can affect the health of Indigenous communities. Chapter III examines both target communities. The first section discusses background information on the Altai Republic, some past threats to water quality, and summarizes current issues facing Altaian peoples. The second section covers the Prairie Band Potawatomi Nation, including a brief history of their people, an overview of water quality issues on the reservation, and a summary of their partnership with the U.S. Geological Survey project.

Chapter IV presents the methodology used in this study. This chapter begins by explaining the interview process, followed by a section describing the test kits used in water-quality testing. There is also a brief review of the parameters analyzed through the test kits, and of possible effects on human health in drinking water from the contaminants assessed.

Chapter V covers the results of the study. The first section discusses cultural traditions of each community related to water resources. This is followed by a discussion of the major sources of contamination, and what information and resources are available to each community. The chapter concludes by making a case for community-based water quality monitoring, and a discussion of the results obtained by the test kits.

The final chapter will summarize the results, and also discuss implications for further research and possible programs that could be implemented in each community.

This study is meant to serve as a preliminary analysis of the problems facing these Indigenous communities. The information obtained will help design a sustainable program for each community that works within the unique needs and culturally imposed constraints of Indigenous Peoples in different parts of the world. This will not be a final solution to the serious issues involved in water quality, nor will it represent a solution for all Indigenous cultures.

It is important to emphasize that certain aspects and themes, such as the spiritual ceremonies related to water, are largely left out of this study in an effort to show appropriate respect for scared cultural knowledge and traditions. In those instances where the information was volunteered to me by these people with a full understanding of the purposes of the study I include statements on this theme. This analysis will hopefully be a small step in bringing awareness to a worldwide problem and ensuring that all communities have access to safe drinking water or, at the least, access to technology that will inform the population of the state of their water supply.

Chapter II

Literature Review

This chapter presents three case studies of water quality issues facing Indigenous Peoples in Canada and two areas of the Amazon. These studies focus on issues of community health and economic prosperity that can be affected by contamination of water resources. The framework of this research focuses on contributing to the mission of Global Indigenous Nations Studies program, which is concerned with the "survival, self-sufficiency, mutual support, empowerment, and decolonization of Indigenous Peoples throughout the world."

Clean water is a concern of people on all continents. When water becomes polluted or otherwise compromised, the effects on a community can be far-reaching. For example, over 4,100 people in Zimbabwe have died from an outbreak of cholera in the drinking water supply ("Zimbabwe diary," 2009; "Zimbabwe: cholera," 2009). The outbreak was caused by weakened public health and municipal services, with local authorities unable to provide potable water, waste collection and adequate sanitation. Such crises may have amplified effects in Indigenous communities around the world, where there are few sources of water treatment, poor oversight of quality, and lack of access to health care. These realities are detailed in the following three studies: "Fish Consumption, Fish Lore, and Mercury Pollution – Risk Communication for the Madeira River People" (Boischio and Henshel, 2000) focuses on mercury contamination in the Madeira River Basin, to illustrate how contaminants not only pose a health risk in drinking water, but can also contaminate major sources of food such as fish. This study also illustrates how traditional protocol of Indigenous People concerning their environment often coincides with western scientific protocols. “Estimating Risks from Exposure to Methyl mercury: Application to First Nations People in Canada” (Hoover, Hill, & Watson, 1997) assesses health risks caused by mercury contamination in a Canadian reservoir, to quantify the threat to human health. “The Use of Riparian Environments in the Rural Peruvian Amazon” (McClain and Cossio, 2003) examines the use of riparian zones in the rural Peruvian Amazon, to focus on agriculture alone riverbanks and its effects on water quality. These three studies are based on the theoretical assumption that when aquatic ecosystems become degraded they can adversely affect the health of the surrounding Native communities who rely on that ecosystem.

In “Fish Consumption, Fish Lore, and Mercury Pollution – Risk Communication for the Madeira River People” by Ann Boischio and Diane Henshel, the researchers focus on the importance of fish in the diets of the Indigenous People (the *Ribeirinhos*) of the Upper Madeira River in the Amazon Basin. Their research examines the need for a fish advisory to address possible health risks for the *Ribeirinhos* People, who acquire their dietary protein primarily by consuming fish from this river source. The *Ribeirinhos* already possess their own “advisory” in the form of a strong cultural protocol regarding catching and preparing fish for human consumption, and this “fish lore”[1] provides the guideline for which fish are safe to eat for certain people in the community. For instance, pregnant or nursing women avoid consuming certain species, such as tuna, that the rest of the population may be able to eat in small amounts. Like many Amazonian rivers the

[1] “Fish lore” is the term used by the researchers to describe the cultural protocol of the *Ribeirinhos* regarding fish consumption.

Madeira system is polluted with mercury (Hg) from human activities such as mining and deforestation. Organic mercury (methylmercury, MeHg) is a neurotoxin that is particularly detrimental to developing nervous systems. Clinical and experimental studies have shown that MeHg accumulates in the central nervous system of the developing fetus, and additional accumulation results after birth from suckling. Exposure to MeHg during development is especially harmful to the child's brain, and may result in neurological impairments and disruptions such as spasticity, ataxia, athetosis, convulsions, and impaired intellectual development (O'Kusky, 1983). It is therefore important that the traditional protocol, or "fish lore," of the *Ribeirinhos* reliably corresponds with the measured mercury levels of each species of fish. In this study the authors hypothesize that mercury ingestion through fish consumption has been a major route of mercury exposure among the riverside people along the Upper Madeira River. Based on this thinking, it is suggested that there is a need to address the risk to the exposed population in the context of health in terms of a formal fish advisory.

The major independent variable of this study is the trophic level of the fish being consumed (Piscivore, Omnivore II, Omnivore I, Herbivore, Detrivore, or Planktophagus).[2] Trophic level refers to the position of the species in the food chain. The mercury concentration for each fish species is dependent on the trophic level because of biomagnification, meaning that species at higher trophic levels, such as Piscivores and Omnivore II, are more likely to have high concentrations of mercury accumulated in their tissues. This is demonstrated by the serious problems with mercury contamination in high

[2] Piscivore, consumes primarily fish; Omnivore, consumes both animal- and plant-life; Herbivore, consumes primarily plant-life; Detrivore, consumes primarily detritus or organic waste; Planktophagus, consumes primarily zooplankton. For more information on trophic levels, see http://www.nature.com/nature/journal/v268/n5618/abs/268329a0.html.

trophic level marine species, such as swordfish, marlin and tuna, where even consumers in Europe and America are advised to limit their intake of these species. This variable was used as the primary predictor of the safe levels of consumption for each species for inclusion in the fish advisory.

This study was carried out in 1991 and 1993. In 1991, the researchers used a systematic random sampling procedure on human subjects to collect data within the whole study area (n=133, or 13 percent of the total population). It was noted that more households were inevitably sampled in villages with higher population densities. In 1993, they evaluated the same communities, but only surveyed households with infant members (n=143). The study is quasi-experimental, because the participants could not be separated from the communities that have already been established, nor could they manipulate whether each house had an infant resident or not. The participants were chosen randomly within these already established groups.

To collect data for this study, information on the number of households in each community was taken from local institutions and adjusted by enumerating the actual households within each community. Undergraduate students from the Federal University of Rondonia administered dietary questionnaires, collected biological samples (hair samples from the population and tissue samples from fish being consumed) and made anthropometric measurements (age/gender, body weight, etc). Whenever possible, the fish that were to be consumed by all family members were weighed on a domestic scale. These weights were used to determine the average amount of quantitative daily fish consumption on a per capita basis. The responses to the dietary questionnaires were used to pattern the qualitative fish consumption of the population.

Daily mercury ingestion through fish consumption was estimated by incorporating information about the average amount of fish daily consumed per capita with data on mean mercury concentrations of various fish species. Levels of mercury ingestion were also evaluated by testing the mercury levels in hair samples from the population. The recommended maximum number of fish meals per week by species was then estimated using the mercury ingestion estimates and average mercury levels found in all fish species.

This study found that the pattern of fish consumption by the Ribeirinhos changes according to the season. The most consumed species of fish were from lower trophic levels, and the least consumed fish came from higher trophic levels, which may be beneficial to overall human health. The mercury concentrations in the higher trophic level groups were significantly higher than those in the lower trophic level groups.[3] The average daily mercury intake of the population was calculated to be 95µg, or 2.60/kg average body weight, which is three times higher than the recommended daily intake of 30 µg.

Boischio and Henshel formed the formal fish advisory based on the trophic level of each species of fish, recommending that lower trophic-level fish containing lower levels of mercury be eaten more often. Based on these qualifications, species of fish compromising the regular diet of the Ribeirinhos were placed into four categories according to the maximum recommended number of meals of each type of fish per week: eat more (4-6 meals/week), eat less (2-3), eat rarely (no more than 1), or do not eat.

There are several possible complications to this study. Information concerning fish consumption might be affected by the subjective nature of the question and the

[3] See Table 3 in Boischio and Henshel, pg. 116.

interviewees' recall bias, though the researchers note that results obtained using interview and observational strategies were consistent. Estimates used to develop the fish advisory were developed employing the assumption that no other mercury-contaminated fish species were eaten during the same weekly period. The hair samples obtained from the community helped to control for the mercury estimates. A caveat to the formal fish advisory is that most of the fish species are only seasonally available. When the fish are available to be taken for food, it is not feasible to ask the community to limit their fish consumption past a certain amount, because it is part of their cultural tradition and a major source of protein.

The study entitled "Estimating Risks from Exposure to Methyl mercury: Application to First Nations People in Canada" by Sara Hoover, Ryan Hill, and Tom Watson focuses on Nechako reservoir in British Colombia, which is shown to have elevated levels of methylmercury due to flooding of a terrestrial system. Fish from this reservoir comprise a large portion of the diet of Native People of the area.[4] The researchers used fish from Ogston Lake and Tezzeron Lake, also in British Colombia, for comparison with the reservoir. Fish from these two lakes are also frequently consumed by Native People of the area. The goal of the researchers was to combine past analyses and assessments to estimate the risks to Native Canadians who ingest methylmercury via fish consumption from these bodies of water.

[4] This study does not mention specific Indigenous populations who fish in the reservoir or lakes in question.

In order to characterize the risk of methylmercury consumption, dose-response analyses of an Iraqi mercury-poisoning episode were combined with probabilistic exposure assessment to estimate the risks to the Indigenous communities. Because fish in systems with elevated levels of mercury tend to accumulate higher levels of methylmercury, the researchers hypothesize that Indigenous People, being the population most likely to consume significant quantities of fish from the reservoir, are the population most at risk for developmental neurotoxicity in their children.

The major study variables for this study were similar to the previously reviewed study on the Upper Madeira. The dependent variable was the amount of exposure to methylmercury for young children of Indigenous populations fishing in the Nechako Reservoir, Ogston Lake or Tezzeron Lake. Exposure was estimated by examining the independent variables, which were the amount of fish consumed (grams per day; g/day), the level of methylmercury contamination in the fish (micrograms per gram; µg/g), and the body weight of the mother (kilograms; kg). The sample procedure for this study doesn’t involve any actual sampling of the target populations, but instead combines previous studies to determine the probable risk of mercury consumption for the Native children. Therefore, the research design is non-experimental, by use of a subject proxy. The researchers used available dose-response data from Iraqi children who were exposed to methylmercury prenatally to correlate expressed neurological effects in infants to the amount of methylmercury dose. They used three quantitative variables of neurological effect for principal components analysis: neurological score, age at first walking, and age at first talking of the affected Iraqi infants. They found that the neurological score accounted for close to 80 percent of variability in the data.

The results of the study suggest that risk of exposure to methylmercury is approximately identical for Native People consuming fish from Nechako Reservoir and Tezzeron Lake, and lower risk for fish from Ogsten Lake. Hoover, Hill, and Watson compared their predicted exposures to measured hair levels obtained in a survey of the Cheslatta Band conducted by Health and Welfare Canada in 1993. The Cheslatta rely on fish caught in waters affected by the Nechako Reservoir. The result was that the researchers' predicted hair levels and mean doses were consistent with those for the Cheslatta. This indicates that the risk assumptions made by the researchers were reasonable. The final analysis found that health risks to Native populations consuming fish from the Nechako reservoir are comparable with other lakes in the region, and to mean risks for the general population. They conclude that the population is not at a significant risk for neurological dysfunction from mercury ingestion.

The study entitled "The Use of Riparian Environments in the Rural Peruvian Amazon" by Michael McClain and Rosa Cossio takes us back to the Amazon, to focus on agriculture along riverbanks. The researchers focus on two communities located in the Palcazu River Basin in Peru; Laguna – Raya, an Amuesha Native community, and Santa Maria, a colonist settlement. Both are agricultural communities that utilize the Palcazu River and its major tributaries. The area between the fields and the river is covered by riparian forests, which are important in regulating flows of water, and in filtering particulates and solutes from terrestrial to aquatic ecosystems. They are important for the maintenance of water quality in surface water systems, especially in an area such as the study location where more than 90 percent of households gather their water for drinking and household use from surface water sources. The water is consumed directly or after boiling. Many local crops are cultivated preferentially in the fertile riparian soil, which indicates to the researchers a need to both conserve and use riparian areas. The main goal of this study is to determine the use of riparian areas by each community, and to lay groundwork for developing viable watershed management programs in the area.

McClain and Cossio address the questions of what activities are focused in riparian areas, what community and extra-community rules regulate riparian area land use in different social groups, and to what extent inhabitants of the region recognize the importance of intact riparian vegetation for protecting adjacent aquatic ecosystems. Because human inhabitants of the region rely on these aquatic resources, the researchers hypothesize that riparian deforestation will have unintended negative feedbacks on the health and well-being of rural communities. They believe that both the agricultural and ecological values of riparian areas may be preserved through proper management.

In this study the major independent variable is the use of the riparian forested areas. The dependent variable is the resultant water quality of the river that provides drinking water for over 90 percent of the households in the area. These variables predict the rate of disease for the surrounding Indigenous communities. In fact, the researchers note that a majority of the illnesses treated at local health clinics are waterborne diseases. The study uses an experimental design, and ultimately the researchers interviewed the entire populations of Laguna – Raya and Santa Maria with the exception of two households.

McClain and Cossio gathered data through a survey of 79 households, which was based on structured interviews to determine the householders' activities involving riparian areas. They also performed an ethnographic study in both communities that included observations, informal conversations and unstructured interviews with householders about their conceptions, classification, and use of riparian areas and general activities. The data was analyzed by quantifying the land use by percentage of each household.

The study confirmed that agriculture is a main activity of both communities. The Native Laguna-Raya community reported that 55 percent of households had access to riparian areas for farming, compared with 76 percent of households in the colonist Santa Maria community. The Santa Maria householders had a longer stretch of the river on their property on average (489 meters [m] compared with 315m for Laguna-Raya respondents), and 75 percent of the households left a forested buffer between their fields and the river that averages 27m in width. Of the Indigenous Laguna – Raya householders, 88 percent reported leaving a forested buffer, but theirs averaged only 22m. The surveys found that 100 percent of the Laguna – Raya population recognized riparian areas as important, while in Santa Maria 81 percent saw them as important and 19 percent perceived the riparian forests as a threat for their crops and property. The main crops in riparian areas for both communities were manioc, plantain, and corn. Laguna-Raya households also reported cultivating peanuts and beans in riparian areas.

This study demonstrated that it is important for the integrity of both water quality and the fertility of the surrounding land that riparian forests be maintained. They directly buffer streams and rivers against inputs of sediments and contaminants from adjoining uplands. The surveys and interviews showed that the people of the Palcazu valley value riparian forests for the protection of the river and fertility of soil. The researchers noted that a greater percentage of households in the Indigenous community (Laguna-Raya) recognized the importance of the forested buffers, and more people from that area reported leaving the riparian forests intact. This is attributed to a stronger communal structure in the Native community that results in a greater respect for buffer area and awareness of their ecological value. It is also noted that financial resources in the Peruvian Amazon are scarce, so natural tools for water quality management are crucial to the health of the region. The results of this study help to lay groundwork to develop a viable watershed management program in the Peruvian Amazon. With proper guidelines, it will be possible to exploit the arable properties of areas such as these without compromising water quality or the habitats and resources they provide.

These three studies were reviewed to illustrate a few of the many threats related to water quality and community health. The first study showed that mercury contamination can pose a health threat to a community food source. This study also illustrates that traditional knowledge (the "fish lore" of the *Ribeirinhos*) corresponds with measured scientific knowledge (the formal fish advisory), and that traditional protocols succeed in keeping the community healthy. The second study was chosen to quantify the threat posed to an Indigenous community by methylmercury contamination in their primary water resource. The final study illustrated how river-bank agriculture can contaminate water resources, and how Indigenous land management theories recognize the importance of riparian zones in remediating agricultural contaminants. All three studies recognize health threats to Indigenous communities posed by contaminated water resources, and are intended to show that this threat extends well beyond the two communities that are the target of my research. Examining cases such as these three, and the issues facing the

Altaian and Prairie Band Potawatomi Peoples, will help further the mission of Global Indigenous Nations Studies, by “understanding the experiences and improving the lives of Indigenous Peoples around the world.”

Chapter III

Description of the Study Areas

The Altai Republic

The Altai Republic of south-central Siberia has a long and rich history. From evidence of the most ancient human histories to tribal governments, Soviet rule and finally as an autonomous republic, the Altai has undergone many rapid changes over time. Though government-imposed land-management practices that have threatened the integrity and beauty of the region, the Indigenous population has resisted all large-scale industry that would have done irreparable harm to their sacred Altai. Today a new threat has emerged in the form of large numbers of tourists, and the Altai is at yet another crossroads. Many people hope they can learn from the mistakes of other countries, and prevent the destruction of their lands and pristine waterways.

The Gorny-Altai, or Mountain Altai, has many well-deserved nicknames including "the Pearl of Siberia," and "the Switzerland of Russia." It is so called because of its unbelievably beautiful landscapes and long tracts of unspoiled, undeveloped land. Here one can find expansive forests of birch and Siberian cedar, wide-open rolling steppes, glaciers and snow-capped peaks rising over 4,500 meters above sea level. This beauty hasn't gone unrecognized by the world community, as the Golden Mountains of the Altai were added to the list of UNESCO World Heritage Sites in 1998. This listing includes the *zapovednik* (strict nature preserve which prohibits all human activity) around Lake Teletskoye, the Ukok quiet zone on the Ukok plateau, and the *Katunsky*

Zapovednik, which contains Mount Belukha and the headwaters of the Katun River (UNESCO, 2006).

Archaeologists have uncovered evidence of human habitation in the Gorny-Altai dating back to the Lower Paleolithic Era (2,500,000 to approximately 120,000 years ago). Recently discovered Stone Age cliff paintings dating back to 8000 B.C. depict hunters on skis, suggesting that the Altai may have been the birthplace of skiing. Similar skiis are still used in the steppe today during periods of heavy snowfall (Oko, 2006). In 1995 Belgian and Russian scientists excavated approximately 30 *kurgans*, or burial mounds, revealing remains of people from the Scytho-Siberian period (700B.C. to 200 A.D.) (Francois, Keyser-Tracqui, Bourgeois, Crubezy, & Ludes, 2004). Some of these remains have undergone genetic analysis in an attempt to retrace human migration across the Asian continent. In another well-known discovery, two well-preserved mummies were excavated from the Ukok plateau by archaeologist Natalya Polosmak in 1993. These mummies, a man and a woman originally thought to be a princess, were found in a burial mound dating back to the middle of the first millennium B.C. ("The Mummies Return, 2004). While these discoveries have made valuable contributions to the reconstruction of ancient human history, many of the current inhabitants of the Altai see these excavations as disrespectful and wish for the remains to be returned to their original burial places.

Contemporary Altaian people are comprised of a number of different Turkic tribes who traditionally lived in the region where the modern-day borders of Russian, China, Mongolia, and Kazakhstan meet. This area historically belonged to emerging and collapsing tribal unions, khanates, and empires of Scythians, Turks, Uigurs, Yenissey, Kirgiz, Kidans, Mongols, and Oirots (Annett, Klubnikin, Cherkasova, Shishin, & Fotieva, 2000). In the 17th and 18th centuries, the Altai region belonged to the khanate of Dzungaria, which buffered the border between Russia and China. In the 1750's, this Oirot state was attacked from the south by the Qin dynasty, allegedly as punishment for disloyal Oirot chieftans. The genocide that ensued completely destroyed Dzungaria. The surviving tribes found refuge in the Altaian Mountains to the north, and begged Elizabeth the Great to allow their region to join Russia for protection from the war (Znamenski, 2005). The Altai consequently became the southern-most border of central Siberian Russia.

The fluctuating tribes eventually gave rise to two large groups: the northern Altaians (comprised of the Tubular, the Kumandin, the Chelkan, and the Shor peoples) and southern Altaians (the Altai-kizhi and the Telengit people). Northern Altaians inhabited the thick forests found in their region, and lived primarily as hunter-gatherers. The Southern Altaians lived as nomadic herders on the vast steppes (Malkov, 2004).

Russian settlement was limited for the first 150 years of the Altai Republic's existence as part of the Russian Empire. The first Russians to arrive in the area were Old Believers, members of the Russian Orthodox Church who did not wish to conform to new reforms instituted by the Patriarch Nikon. Fleeing religious persecution, many people found new homes in regions of Siberia, including the Altai. A small number settled there during the last half of the 17th century.

In 1830, Russian Orthodox missionaries came across a small settlement in the Maima Valley, nestled in the Altai Mountains. This mostly Indigenous settlement was then called Ulala, and became the site of the first Orthodox mission in the Altai. Around the turn of the 20th century, a famine in European Russia persuaded the tsar to reconsider allowing Russian settlement in remote areas of Siberia, including the Altai. Many Altaians became wary of the unregulated influx of Russian settlers into the area, and the resulting land dispossession. Ulala was quickly growing from a small settlement into a town. The Altaians protested to the government, and in 1917 tried to form their own Duma. A semi-autonomous region was created for the Altai people on June 1, 1922, called the Oirot Autonomous Oblast (Ойро́тская автоно́мная о́бласть), with Ulala as its capitol. This action united the different Turkic groups under a single government with a herding-based economy. On January 7, 1948 the region was renamed Gorno-Altai Autonomous Oblast (Го́рно-Алта́йская автоно́мная о́бласть), and the name of the capitol was changed to Gorno-Altaisk. In 1991 the region was reorganized into the Gorno-Altai Autonomous Soviet Socialist Republic (ASSR), and finally became the Altai Republic in 1992 (Gorno-Altaisk, 2006).

Soviet Land-Management

Traditional land-management practices in and around Gorno-Altaisk sustainably supported the surrounding ecosystems. Similar to Indigenous People in North America, the Altaians have strict cultural protocols that define the treatment of resources and prohibit taking too much. In their animistic belief system, everything is imbued with a spirit, including mountains, rivers, and springs, and these spirits must be respected lest they stop providing for the people. Under Soviet rule these sustainable practices were threatened, and the ecosystems of the Altai nearly destroyed.

In the 1930s, the Soviets created collective farms in the Altai region, with the purpose of forcing the local people to produce certain quotas of meat and fur to support the Soviet army. The immediate consequence of this system was the abolishment of traditional tribal and family structures, as well as the nomadic-herder lifestyle. Over time, negative impacts were compounded on the land. As the required quotas were increased, more land was required to hold the quantity of livestock needed to meet the demands. Traditionally, small herds were moved seasonally across the fragile soils of the Altai, reducing the impact of livestock grazing. Because the farms were forced to be stationary under this system, the land never had a time to recover, and quickly became overgrazed. By the 1950s, traditional lands were being grazed to capacity, forcing the Altaians to move their herds into the mountain regions and previously un-grazed habitat, damaging the land and displacing local wildlife. By the mid-1980s, all land that could possibly be grazed was being exploited (Malkov, 2004).

The local villages in the Altai traditionally use water from wells and creeks in their homes, and get their drinking water primarily from springs. The destruction of the land under the imposed farming system also threatened local bodies of water, and consequently human health. People living in the Altai follow cultural protocols indicating springs that are safe to drink from, but overgrazing contaminated many of the drinking-water sources that had been relied upon for centuries. The large concentration of livestock consumed the groundcover and turned up the soil with their hooves, causing soil and fecal matter to wash into rivers and streams unfiltered. Common water contaminants seen in overgrazed areas include bacteria such as *E. coli*, and nitrates. Bacterial contamination in drinking water can cause severe gastrointestinal illness. Children are particularly susceptible to diseases caused by these pollutants. In children under the age of 5, an *E. coli* infection can cause a life-threatening complication called hemolytic uremic syndrome, which destroys red blood cells and causes the kidneys to fail (USEPA, 2006). High levels of nitrates in drinking water can cause methemoglobinemia, or “blue-baby syndrome” in infants. This is a serious condition in which nitrates enter the blood stream and bind to hemoglobin, reducing the ability of the blood to carry oxygen to the tissues. An infant afflicted with methemoglobinemia will literally turn blue from lack of oxygen.

The threat to local water resources was compounded by an increased risk of disease transmission between herd animals and from the livestock to humans. In order to control disease transmission by parasite, the people bathed their animals in chemical pesticides. The water from these baths washed into the streams and rivers, which not only harmed people but damaged fish populations, with populations in small streams sometimes being eliminated entirely (Malkov, 2004).

Collective farms were disbanded beginning in the 1980s, and were completely abolished by the fall of the Soviet Union. Since their dismantling, the concentration of livestock has been reduced drastically, allowing the land and many wildlife populations to recover. However, most of the population has fallen into poverty as a result of decentralization and the decreased demand for livestock products. Since the end of Soviet times, the Altai has been considered one of the poorest areas of Russia. David Khadaryov, a young graduate student from the Altai, stated that “there are plenty of places to spend your money, but nowhere to make it” (Khaydarov, D., 2006, *personal communication*). The Altaians have managed to keep most industry out of their area, never falling prey to the pulp mills that pollute Baikal or the large-scale mining operations that plague regions like Kuzbas. This has sustained the natural beauty of the Altai, but also crippled the economic development of the population.

Eco-tourism and important sites in the Altai

Today tourism is considered the primary means for economic growth in the Altai Republic. However, the sacred objects of the Altaian landscape are the most attractive sites for tourists, many of whom do not understand the significance of the places or the appropriate reverence with which to behave. While Gorno-Altaisk is benefiting from rapid economic development and the construction of new hotels and restaurants, the remote high mountain districts witness negative aspects of tourism: pollution of ecosystems, trash at sacred sites, ignorance and disrespect to Indigenous cultures, unsanctioned diggings of *kurgans* (burial mounds), and destruction of petroglyphs. Because of this, many local Indigenous communities consider tourism as a real threat to their traditional livelihoods and cultures (Statement by Chagat Almashev, LIENIP). This theme will be discussed further in the "Results" chapter.

Three popular areas of the Altai are seeing some of the most rapid detrimental effects of tourism. These are Lake Teletskoye, the Katun River, and the many local sacred springs.

Lake Teletskoye

Lake Teletskoye is located approximately 200 kilometers to the east of Gorno-Altaisk, and is reputed to be the Altai's oldest tourist destination. Two villages are located there, one on the north shore and one on the south shore of the western-most tip, where the lake is drained by the Biya River. This is also the area where all of the tourist camps are located. The remainder of the lake and surrounding area is part of the *Altaisky zapovednik* included in the UNESCO World Heritage listing. Strict fines are imposed on anyone caught within the reserve.

The lake, formed by the divergence of at least two fault lines, lies 434 m above sea level, and is 78 km long and 5 km wide. It is one of the deepest lakes on earth at a measured 325 meters, and holds at least 40 km^3 of clean, fresh water. The water is so clear that measurements using secchi disks have placed the depth of visibility at up to 13 meters (Annett, C., 2005, *personal communication*). Many people consider Teletskoye to be a smaller version of Baikal, a large rift lake in eastern Russia.

Initially it was the local population who visited Lake Teletskoye for its beautiful scenery and clear waters, which were reputed to have healing powers. Very few roads were available to access the area, with tourists mostly coming by foot or horseback across the mountains. In the early days of motor vehicles, only a few dirt roads were constructed to access the area, but with the booming popularity of the lake, it quickly became accessible by paved roads. A few popular attractions, such as the "Dragon Hole" (the purported site of an ancient meteor crash) and Korbu waterfall lie scattered around the lake. It is prohibited to build roads to these sites through the *zapovednik*, which creates a market for tours of the lake by motor-boat. For a small fare, a tourist can hire a boat to drive down the east-west corridor of the lake, to the shore just past the large bend to the south where Korbu waterfall lies. It takes nearly an hour to reach the waterfall by speedboat, even though this tour covers a relatively short length of the lake.

The Katun River

The Katun River is a beautiful rolling river, bordering the north-west edge of the Altai Republic near Gorno-Altaisk. Many local legends and stories exist about the Katun. One story passed down through oral tradition and associated with talismans, describes how the Katun came to join with the Biya, which drains Lake Teletskoye, to form the mighty Ob River:

> A long time ago the Katun was a wild, uncontrollable woman, and the Biya was a strong, calm man. Katun and Biya fell in love, but Katun's father forbade her from seeing Biya. He tried to keep her from him, but Katun ran away, taking a wild course through the land. Her father sent his guards down in the form of mountains to stop her. They would land right in front of her, but she went around them every time. Finally, Katun's father himself tried to stop her, but she dashed around him too, finally joining her beloved Biya. They formed the Ob River, so that they might be together forever.[5]

For the Altaian People, the Katun is a living organism with a spirit to be revered and respected. The river originates in the glaciers on the southern slope of Mount Belukha, and the glacial melt gives it a characteristic milky blue color in the summertime. Local people follow a code of behavior designed to show respect to the river. This includes refraining from throwing stones or other debris into the river, and not taking water at night (Annett et al., 2006). Traditional Altaians "meditate" to find the right frame of mind before approaching the Katun.

For most of the 20th century, the threat has been looming of construction of a series of hydroelectric dams on the Katun River. If built, the reservoirs would cover 5 percent of the already scarce agricultural land in the Altai Republic, and displace many local villages. The flood would submerge culturally significant land containing burial mounds, petroglyphs, and ancient settlements. The proposed dam site itself is a location

[5] Common local story repeated many times during my visits to the Altai Republic.

of origin stories of local Indigenous People. In addition, there is evidence to suggest that this project would flood the Saransinsky mercury zone and poison many lakes and streams in the Altai Mountains. To add insult to injury, the electricity generated by these dams would be intended for the Siberia Joint Power System, and not for local consumption (Annett et al., 2006).

Construction of a dam on the Katun was begun in 1982, but promptly halted by widespread environmental protests. This type of protest was unprecedented during the Soviet Period, and focused mainly on the concept of treating water in a respectful fashion. In 1991, Altaian protestors succeeded in getting the Katunsky reserve around the headwaters of the river included as a UNESCO World Heritage site. Though an occasional dam proposal still arises from time to time, advocates for the Katun River remain firm.

In a statement to the Economic and Social Council Commission on Human Rights in Geneva, Switzerland in 2006, a representative of the Lauravetlan Information and Education Network of Indigenous People (LIENIP) and the Foundation for Sustainable Development of Altai (FSDA) addressed the paradoxical problem of tourism as the primary means of economic growth in the region, and also the primary threat to its ecological health. These organizations support the development of regional parks owned by Indigenous leaders in the Altai Republic of Russia, as well as development of an ethnic tourism program backed by local communities. They see this as the only sustainable way to develop the region (Statement by Chagat Almashev, LIENIP). The Altaian People will face many challenges in the future regarding respect of their cultural practices and protection of the local environment.

The Prairie Band Potawatomi Nation

The Prairie Band of the Potawatomi Nation (PBPN) currently lives on a reservation located in northeast Kansas, just north of Topeka. After enduring the many hardships and damaging government policies that brought them to Kansas, they are restoring their community and revitalizing their economy. However, as the population on the reservation grows and thrives, so does their need for reliable sources of water. The demand for water has presented the tribe with an opportunity to increase their sovereignty by ending their dependence on state-owned water supplies and meeting tribal water demands with their own ground and surface water sources on the reservation. As a step towards this goal, the tribe has partnered with the U.S. Geological Survey to determine the quality and quantity of the water available on their reservation.

The Prairie Band of the Potawatomi tribe originated in the Great Lakes Region of North America. After their first contact with European colonizers in 1641, their homelands became an issue of contention. Over the years the tribe was repeatedly persuaded into ceding portions of their land, leading up to the Indian Removal Act of 1830. Though the Potawatomi Chief Shab-eh-nay had secured two sections of land near Paw Paw Grove, Illinois in the 1829 Treaty of Prairie du Chien, the tribe was still forced to move. In 1849, this land was illegally sold through public auction by the U.S. Government. Because an act of Congress or a subsequent treaty is needed to extinguish the Tribe's rights to the reservation and it wasn't included in the cession treaties, the

Prairie Band still claims a legal right to the land (Daniel Dyer, 2005, *personal communication*).

During the forced migration of the Potawatomi Nation, they found temporary homes in Missouri and the Council Bluffs area of Iowa. In both areas the tribe held up to five million acres. They were finally relocated to present-day Kansas in 1846, to a reservation that encompassed only thirty square miles and included part of present-day Topeka. Less than ten years later, the Kansas-Nebraska act of 1854 opened this territory to European settlement. The settlers were squatting on the land before it was even officially taken from the Potawatomi by treaty.

Around this time the Potawatomi Nation experienced an internal divide. A majority of the members wanted to take individual allotments of land being offered by the U.S. government, in the hopes of eventually becoming citizens of the U.S. A smaller group wished to remain true to their heritage and their belief that the land belonged to everyone, not individual owners. This group of approximately 780 people became the Prairie Band of the Potawatomi Nation.

The 568,223 acres that remained of the Potawatomi reservation was divided among different interests by two treaties, one in 1861 and 1867. The railroad received over 338,000 acres, Jesuit interests 320 acres, Baptist interests 320 acres, and the rest was divided into separate plots. The Prairie Band Reservation was initially established on 11 square miles in the northeast corner of the original reservation. The total Potawatomi holdings that had begun at 568,223 acres in 1846 had decreased by 1867 to only 77,357 acres (Prairie Band Potawatomi Nation, 2006).

In 1887, the Dawes Act finally forced the Prairie Band Potawatomi to divide their lands into private plot holdings. They tried to refuse the allotments, but were punished by the withholding of federal payments, and the double allotments of their land to Europeans, Indians from other tribes, and relatives of the residing agent. Much of the land that was allotted to them was difficult to farm, and they received little help of any kind adapting to this way of life (Prairie Band Potawatomi Nation, 2006; Daniel Dyer, 2005, *personal communication*).

Today, the Prairie Band Potawatomi Reservation is located about 20 miles north of Topeka in northeastern Kansas, and covers an area of 121 m^2 in Jackson County. After suffering hardships under the Dawes Act and Indian Reorganization Act, the community has been revitalized in recent years. In 2001, 10,300 acres of land was able to be purchased and returned to the reservation. Their casino, opened in 1998, has provided income and the means for improvements across the reservation. The Nation has implemented a number of projects, including a road improvement project, an early childhood education center, a language preservation project, a fire station, a Boys and Girls Club for the reservation, and a housing village for tribal elders. Employment and business opportunities are increasing, along with the economic viability of the reservation (Daniel Dyer, 2005, *personal communication*; personal observation, 2003-2009).

The economic revitalization has also encouraged a population increase on the reservation and, consequently, an increase in their need for reliable sources of water. The tribe has estimated that the population on the reservation will increase from 1,625 residents to 2,935 by 2040. During that same period, commercial demand for water is projected to grow from 50,250 gallons per day up to 94,750 gallons per day, and residential demand is expected to increase from 186,875 gallons per day up to 337,525 gallons per day (Prairie Band Potawatomi Nation, 2006).

Currently, the reservation is served by Jackson County Rural Water Districts #1 and #3, Potawatomie County Rural Water District #4, and private water wells. Ground water is used as a domestic water supply throughout the reservation, and is a possible source of water for other practices on the reservation as they develop a stable economic base, such as supplying the casino. Three creeks draining the reservation provide for the fishing and hunting needs of tribal members: Soldier (locally referred to as Big Soldier Creek), Little Soldier, and South Cedar Creeks. It is important to the tribe to maintain the quality of the surface and ground water, as well as the level of in-stream flow, such that it poses no danger to human health and protects the wildlife resources on the reservation.

There have been periods in recent years during which the demand for water on the reservation exceeded the amount available. In light of this, the Tribal Council asked the Bureau of Reclamation (BOR) to assess water supply and demand for the reservation in order to guide long-term community planning. Based upon the proposed future developments for the reservation, the BOR study concluded the reservation water supply would not come close to meeting their future needs. Consequently, the Tribal Council has set a goal of securing an adequate supply of water and an adequate water system to meet the Reservation's needs for the next 40 years (Prairie Band Potawatomi Nation, 2006).

Under the Federal Clean Water Act of 1972, an Indian tribe is sovereign for the purposes of delegating the authority to regulate water within reservation boundaries. Any standards they set would apply to water flowing onto their lands as well as the water channels on the reservation (Federal Water Pollution Control Act, 2002). In order to develop a water plan for the reservation, including setting water-quality standards, the Prairie Band Potawatomi tribe has partnered with the U.S. Geological Survey (USGS) to define baseline quality, and monitor changes in surface- and ground-water on the reservation.

The tribe began their partnership with USGS in 1996. The tribe's goals are: determining the quality and availability of ground and surface water on the reservation, setting water quality standards for the reservation, and training tribal personnel in water quality sampling methods (Schmidt, H.C.R., 2004, presentation at Haskell Indian Nations University). They are currently investigating the possibility of digging new wells on the reservation to meet their community water needs. This would give the tribe independence from the local authority, and increase their sovereignty as a Nation (Daniel Dyer, 2006, *personal communication*).

The two major drainage basins in the area are the Soldier and Little Soldier Creeks. The primary land uses in the basins are cropland (26–27 percent) and pastureland (64-69 percent), with the croplands located mostly along the streams and pastureland in upland areas (Schmidt, 2004). Nonpoint sources such as runoff from agricultural lands and seepage from septic systems or sewage lagoons servicing a rural population are considered the primary sources of potential water-quality problems on the reservation (Trombley, 2001). Three wastewater facilities are operated by the tribe within reservation boundaries and are potential sources of point-source wastewater discharge.

The USGS project conducts testing of surface water four times every year, and tests groundwater once annually. The water samples are analyzed for physical properties, major ions, trace metals, nutrients, bacteria, pesticides, total suspended solids, and suspended sediment, with groundwater being analyzed additionally for volatile organic compounds (VOC) (Trombley, 2001; Schmidt, 2004).

Surface water quality monitoring sites were selected to represent spatial distribution across the reservation, surface water flowing into and out of the reservation, as well as surface water downstream from potential sources of contamination. Twenty sites were established to test annually, and five of those sites were tested quarterly. Two of the quarterly sites are on Big Soldier, and two on Little Soldier, where the water flows onto and off of the reservation. The other site is on Big Elm Creek, downstream from a sewage treatment site. In addition to the surface testing sites, eleven groundwater test sites located across the reservation were added to the study in 2001. Water in these wells is derived from alluvial and glacial deposits as well as Permian- and Pennsylvanian-age carbonate deposits (Schmidt, 2004).

All of the surface testing sites are located near croplands of wheat, corn, or soybeans, which are regularly treated with pesticides and herbicides. In most fields the farmers have left areas of native grasses between the crops and the creeks to serve as filter strips. However, these riparian areas are absent in some fields. Daniel Dyer, the former land manager for the reservation, began a project in 2005 to plant filter strips in these areas. They have also placed erosion monitoring pens at four sites along the Big Soldier, to monitor the stability of the riverbanks. To further help avoid soil erosion, the tribe does not currently practice till-farming in their fields (Daniel Dyer, 2005, *personal communication*; personal observation).

Ongoing analysis of surface water has revealed that total phosphorous, triazine herbicide concentration, and fecal coliform bacteria occasionally exceed water quality standards set by the U.S. Environmental Protection Agecy (EPA). Fecal coliform, which enters the water primarily from overland runoff of livestock pastures, has shown a decrease in recent years, though it still exceeds EPA standards. It is present in some quantity in the majority of samples taken. The Big Elm test site has shown an increase in total phosphorous over time, presumably from the wastewater site upstream. There is concern that the high nutrient concentration could cause excessive algal blooms and deplete the dissolved oxygen concentration in the creek. The Big Elm eventually flows into the Kansas River.

The site on Big Elm Creek, as well as one groundwater site, has shown dissolved solids concentration exceeding the Secondary Drinking-Water Regulation of 500mg/L set by the EPA. According to EPA guidelines, excess dissolved solids are objectionable in drinking water because of possible physiological effects, unpalatable mineral tastes, and higher costs because of corrosion or the necessity for additional treatment (USEPA, 2000).

Sediment also poses a threat to surface water on the reservation, especially in Big Soldier Creek. It enters the water from cropland, dirt roads, and construction sites on the reservation. The presence of suspended sediment or high turbidity can indicate the presence of higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria (USEPA, 2000). It can also threaten aquatic life by limiting light penetration.

Groundwater analysis on the reservation has shown high concentrations of dissolved solids and arsenic in some wells. There is also infiltration of nutrients from surface application, as well as pesticides and herbicides from croplands. The groundwater well showing the most promise for supply development (site MW03) had the highest concentrations of dissolved chloride and sulfate. Site MW06 is a projected domestic source, but has had consistently high levels of arsenic. Domestic supplies on the reservation are often not treated under the current system.

Other significant detections included concentrations of sodium, sulfate, nitrate and arsenic exceeding the water quality standards set by the USEPA. Triazine herbicides (specifically atrazine) were found frequently in surface water samples, although they did not exceed the EPA Maximum Contaminant Level of 3.0 µg/L as an annual average.

The most recent study published by the USGS concluded that the water quality on the Prairie Band Potawatomi Reservation generally meets water-quality criteria established by EPA. Surface-water quality on the reservation is affected primarily by agricultural runoff (triazine herbicides and fecal indicator bacteria), seepage from septic systems or sewage lagoons serving a rural population, and wastewater discharge from documented point sources (dissolved solids and sodium). The total phosphorus in streams can be attributed to both agricultural activities and human and animal waste. Ground-water quality on the reservation most likely is affected by agricultural practices, indicated by the detections of nitrite plus nitrate. Elevated dissolved-solids and arsenic concentrations in the water likely are affected by dissolution of sedimentary rocks. Concentrations of dissolved solids and sulfate in some ground-water samples exceeded their respective Secondary Drinking-Water Regulations, and concentrations of sodium exceeded the taste threshold of the EPA's Drinking-Water Advisory Level. The most recent study concludes that in the event that ground water on the reservation is to be used as a drinking-water source, additional treatment may be necessary to remove excess dissolved solids, sulfate, sodium, nitrite plus nitrate, and arsenic (Schmidt, Mehl, and Pope, 2007).

The possibility of using local groundwater as the reservation water source may be realized in the coming years. More testing is needed to ensure the reservation community, including the crops, herds, and wildlife, stay healthy. This may also involve further changes in land management practices to improve the quality of their surface water. The tribe's ultimate goal of meeting the reservation water needs from tribally-owned resources and increasing their sovereignty is a possibility in the coming years, and can be realized with the commitment of community members, farmers, and government officials on the reservation.

Chapter IV

Methodology

Both the Altaians and the Prairie Band Potawatomi Nation (PBPN) regard themselves as sovereign tribal entities: The Altai as a distinct group and the Potawatomi as federally recognized tribal government. Both have expressed a desire to use their local water resources for drinking and domestic use and as a way to maintain their traditional hunting and fishing rights. One goal of this research is to ensure that they can do so in a knowledgeable manner understanding the benefits and the risks that local water may pose to their health and well being. Steps towards this goal are also steps toward increased sovereignty, as reliance on the colonizing government is reduced. In order to proceed toward this goal, this study was designed to answer the following three questions:

Major Research Questions:

1. What are the attitudes and values of the Indigenous People of the Altai Republic and the Prairie Band Potawatomi Nation toward their water resources?
2. What information is available to these communities regarding water quality and the safety of their water resources?
3. Would these communities benefit from a community-based water quality monitoring program using simplified test kits to better inform them of the quality of the water?

Considering these questions and the information detailed in the previous chapters, I hypothesize that water quality will be an extremely important issue to both of these communities. Because of the Prairie Band Potawatomi Nation's partnership with USGS, it is much more likely that their tribe will be more informed of the state of their water resources than the people of the Altai Republic. With respect to sovereignty the Altai peoples are at a distinct disadvantage compared to the PBPN since they are not recognized as a distinct federal entity. However, it is clear that both communities wish to use their water resources for various uses, instead of simply relying on municipal water sources and giving up traditional hunting and fishing practices. I expect that both communities will respond positively to the idea of a community-based water quality monitoring program that will help them meet their goals.

Data Collection

To answer these research questions this thesis employed the use of face-to-face oral history interviews. Oral history is an important and respected tool for gathering information in many Indigenous communities due to the intimate nature of the contact that value and validates the storytelling of the individual. . The interviews were conducted with the goal of discovering the awareness of quality of water resources, the contemporary and traditional attitudes about these resources, and what information is available to community members. Specifically, the interview process can be defined as qualitative participatory action research (PAR), because the problem being addressed (water quality) was originally identified by the communities experiencing the problem, the research process will give power to the participants to define the scope of the problem and solution, and the results can be cycled back to the people and used by and benefit the participants and community.

Sample

Due to time constraints, lack of availability of subjects, and financial constraints, this study employed a "self-selected" sampling procedure. The interviews were conducted in two sets. The first set of people included citizens and officials of the Altai Republic, and took place in July of 2006. The second set of interviews involved citizens and officials of the Prairie Band Potawatomi Nation, and were conducted in the spring of 2007. Participants were chosen to represent the best available cross-section of stakeholders and experts in each community.

Participants from the Altai Republic included two young female Altaian students, a young chemist, a chemistry professor, and a linguist, all of whom I became acquainted with through the exchange project between Gorno-Altaisk State University, Haskell Indian Nations University, Kansas University, and Kansas State University. This set of interviews also included a public relations representative from the Sanitation Service of the Republic, and four employees of the Lake Teletskoye summer camp, with whom I was previously unacquainted.

The set of interviewees from the Prairie Band Potawatomi Nation was considerably smaller. This group included two employees of the PBPN Department of Planning and Environmental Protection, two people serving as PBPN land manager and construction manager, and a community member in his early thirties. Additional information regarding the PBPN water resources was also available from USGS from their research partnership with the tribe.

The interview process for this study was straightforward and informal. I began by making it clear to the participants that the information would be used to answer my research questions, and assuring them that I wouldn't push them for any private information, such as details of religious practices. I conducted the interviews as a conversation, asking only a few questions and letting the information flow naturally as much as possible. Questions were open-ended, to allow participants to contribute as much or as little information as they wished. All interviews were tape-recorded and subsequently transcribed.

The interviews had the primary focus of determining the relationship of local water resources to the people's culture and traditions. I also wanted to find out whether the community had experienced problems with water-borne illnesses, and what resources were available to a person who wished to test their water or find out information on water quality. Participants were asked about personal experiences and about community knowledge in general.

Limitations of Research

The interview process had several limitations. First, a majority of the samples were self-selected which may lead to an overabundance of extreme viewpoints and perspectives and a lack of mid-range responses that are not representative of the general population from which these samples are drawn. Second, while most citizens of the Altai Republic whom I interviewed spoke English, there were times when I felt that we were not communicating effectively. There was a similar limitation in working through a translator with non-English speakers. Occasionally I had the distinct impression that something had been lost in translation. I would have preferred to interview more people living in outlying villages, but access to these areas is difficult, and it was nearly impossible to set up a time when I could travel there, with a translator, and meet with random community members. Third, the sample from PBPN was limited by its size and representativeness of the community. Three of the four individuals I interviewed held professional positions in the tribal government and one was a community member. I would have preferred to interview more community members. I view this study as laying groundwork for more extensive research in the future.

Quantitative Water-Quality Tests

To compliment the interviews, I conducted water quality tests of surface and ground water resources using Green Water Monitoring Kits, manufactured by LaMotte laboratories.[6] The primary purpose of this exercise was to show that these kits could be a cost-effective tool that is easy to use for the evaluation of water resources, yet provides sophisticated results. The tests use color-coded chemical reactions to indicate the pH, general concentration of dissolved oxygen, nitrate, and phosphate, and the presence or absence of fecal coliform bacteria in a water quality sample. They also measure temperature and turbidity of the sample. Upon implementation of a community-based water quality monitoring project, this type of monitoring kit will be either distributed or made available to the communities.

[6] Information on GREEN low-cost water monitoring kits available at http://www.lamotte.com/pages/edu/5886.html.

These parameters are important basic measures of water quality. They are often affected by other parameters, and can serve as indicators of a larger problem. For example, turbid water, though not generally harmful in itself, can be associated with harmful contaminants such as asbestos, lead, bacteria, viruses, and protozoan cysts such as *Giardia Lamblia* and *Cryptosporidium* (Schmidt, 2004). Physical parameters such as pH and temperature will not typically have a direct effect on human health in drinking water, but can cause stress on aquatic life that people may rely on as a food resource.

The following section describes the parameters covered by the test kits, their effect on human health, and applicable guidelines. There are many additional threats to water quality not explored here, including pesticides and volatile organic compounds. It is a leading concern in the world today to ensure that, no matter what the pollutant or the source, all communities have fresh water available.

The pH of water indicates the degree of acidity or alkalinity of a solution. On a scale of 1 to 14 standard units, a pH of less than 7.0 is considered acidic and greater than 7.0 is defined as basic or alkaline. The pH of natural stream water, as well as ground water, normally ranges from 6.0 to 8.5 standard units (Hem, 1992). A pH level that is beyond this range can cause stress on aquatic organisms, and also may increase the capacity of water to erode the surrounding substrate. Consequently, the Kansas Department of Health and Environment (KDHE) established a surface water quality standard for pH of 6.5 to 8.5 standard units for the protection of aquatic life (KDHE, 2004).

Dissolved oxygen is frequently measured as an evaluation of surface water quality, and is crucial to the survival of aquatic organisms. Dissolved oxygen refers to the amount of gaseous oxygen (O_2) dissolved in aqueous solution. The concentration of dissolved oxygen in water is affected by atmospheric reaeration (how rapidly the water is moving), photosynthetic activity of aquatic plants, and the temperature and salinity of water (Hem, 1992). The KDHE has set an aquatic-life support standard of not less than 5.0 milligrams per liter (mg/L) dissolved oxygen in surface water (KDHE, 2004). Dissolved oxygen is not commonly measured in ground water (well water), due to various difficulties in sampling and a lack of useful information that could be obtained from such samples. This is not to say that ground water is deficient in dissolved oxygen; in fact, ground water can be expected to have dissolved oxygen concentrations similar to that of surface water, unless the water has encountered oxidizable material below the land surface (Hem, 1992). If performed carefully, dissolved oxygen measurements in ground water can be an indicator of the oxidation-reduction (redox) environment of the water in the vicinity of the well.

The test kits are able to analyze the general concentrations of nitrate and phosphate in a sample, which are nutrients vital in plant and animal nutrition: nitrogen compounds are the building blocks for protein synthesis, and phosphorus is relied on as an energy source in cellular chemical reactions (Schmidt, 2004). However, it is important to stop excessive nutrient concentrations from being introduced into aquatic systems, as large influxes of nutrients into bodies of water can result in algal blooms (Hem, 1992). Rapid, dense algal growths cause taste and odor problems in drinking water, reduced aesthetic value of lakes and streams, and stress on other aquatic organisms due to decreased dissolved oxygen concentrations after the algal bloom dies (Trombley, 2001). This problem is often seen downstream from croplands, farms, and uranium ore processing plants, which discharge substantial amounts of nutrients.

Most of the earth's atmosphere is nitrogen gas, but only a small amount of nitrogen is naturally present in the hydrosphere. Human activity contributes nitrogen to bodies of water through the production and use of synthetic fertilizers, including ammonia and other nitrogen compounds. The fertilizer industry has been expanding tremendously over the past decades. In Kansas for example, the amount of fertilizer sold increased from about 180,000 tons in 1950 to more than 1,100,000 tons sold in just 6 months during 2003 (Kansas Department of Agriculture, 2004). Farm animals also contribute substantial amounts of nitrogenous waste to aquatic systems. Nitrogen compounds are measured and reported in various ways by different laboratories. The tests performed as a part of this study are generalized, and measure only the nitrate ion, NO_3^-. This type of test will indicate the presence of excessive nitrate and give an estimate of the amount of nitrogen in the water sample, but may not represent the total nitrogen content.

Though the U.S. Environmental Protection Agency (EPA) has set criteria for chronic ammonia exposure for fish, no water-quality criteria have been established for nitrate for the protection of aquatic life. However, ingesting large concentrations of nitrate through drinking water poses a health threat to infants and small children. It can result in a condition called methemoglobinemia, or blue-baby syndrome. It is so called because the child's skin often turns a bluish or blue-gray color, due to the reduced ability of the blood to carry oxygen and carbon dioxide. Prolonged exposure, or exposure to a large amount of nitrate, results in worsening symptoms such as hypoxia, coma, and seizures, and may ultimately result in death. Because of this risk, there is a maximum contamination level (MCL) in drinking water of 10 mg/L nitrate as nitrogen established by the EPA (USEPA, 2000).

Phosphorus is always present in human and animal metabolic waste, and consequently a substantial amount is contributed to surface water through domestic, municipal, and industrial sewage effluents. Excessive phosphorus concentrations are a critical factor in eutrophication of a water source, which is characterized by decreased dissolved oxygen concentrations, increased nutrient concentrations, and dense algal growth, and can also interfere with water treatment. The EPA's goal for total phosphorus in surface water is 0.10 mg/L. At this concentration eutrophication and interference in water treatment is limited (USEPA, 2006).

There are several different types of bacteria that inhabit the intestinal tract of warm-blooded animals, and may enter into aquatic systems through seepage from pastures and feedlots, or by sewage lagoons and from wildlife populations. These bacteria include fecal *Escherichia coli (E. coli),* fecal streptococcus, and enterococci bacteria. Fecal coliform is a group of bacteria which can include *E. coli* and species of the *Klebsiella*, *Enterobacter,* and *Citrobacter* genera. A positive test for fecal coliform bacteria is a strong indication of fecal contamination and the possible presence of disease-causing bacteria such as *E. coli*.

Drinking water contaminated with harmful bacteria can make a person very sick, resulting in severe diarrhea and other ailments. In young people, elders, and people with compromised immune systems, the effects can be particularly severe. About 2 percent to 7 percent of infections in people cause a complication called hemolytic uremic syndrome, in which the red blood cells are destroyed and the kidneys fail. In the United States, hemolytic uremic syndrome is the primary cause of acute kidney failure in children. Most cases of hemolytic uremic syndrome are caused by a strain of bacteria labeled *E. coli* O157:H7 (USEPA, 2006).

Water from municipal sources in America is treated using chlorine, ultra-violet light, or ozone, all of which act to kill or inactivate *E. coli*. It is also possible to remove most strains of fecal coliform bacteria by boiling water at a rolling boil for one minute. Domestic water sources in America are required to be disinfected to ensure that all bacterial contamination is inactivated before it is to be consumed (USEPA, 2006).

Turbidity is a measure of the clearness or cloudiness of water. High turbidity levels are often associated with high levels of disease-causing microorganisms such as viruses, parasites and certain types of bacteria, and also may interfere with the disinfection of drinking water (Schmidt, 2004). In natural systems turbid water can threaten the aquatic life within it by reducing the distance that sunlight can penetrate water, lowering temperatures in the system and limiting available oxygen. The EPA has set water-quality criteria for surface water in streams and rivers, and in finished drinking water. The criteria set for surface water varies by defined ecoregions, or areas of similar ecological variables. The EPA states that turbidity in finished drinking water must not exceed 5 nephelometric turbidity units (NTU), and water-filtering systems must produce finished drinking water that does not exceed 1 NTU in at least 95 percent of daily turbidity samples (USEPA, 2006).

For quality assurance and to determine whether the kits are accurate indicators of water quality, their results will be compared with historic results from the same sites. This study is preceded by two years of water quality data from the Altai Republic, and ten years of data from the Prairie Band Potawatomi Nation. The former was gathered by Altaian, Russian, Indigenous American, and American students involved in a scientific and cultural exchange between University of Kansas, Kansas State University, Haskell Indian Nations University, Northern Arizona University, and Gorno-Altaisk State University (Lukyanenko & Annett, 2002; Malkov & Annett, 2004). Data from PBPN has been gathered by the United States Geological Survey (USGS) since 1996 in a joint effort with the Potawatomi Nation to monitor and describe water resources on the reservation (Trombley, 1999 & 2001; Schmidt, 2004; Schmidt, Mehl, & Pope, 2007).

The samples analyzed by the kits were gathered in field-rinsed water bottles, usually in mid-morning or afternoon. Tests of water temperature and dissolved oxygen were always performed on-site. The remaining tests (pH, nitrate, phosphorus, turbidity, and fecal coliform) were performed on-site if time allowed, but many times were brought back to the "base camp" (an apartment or a lab, depending on location) for analysis. Tests were performed by the researcher and student assistants.

In the Altai Republic, samples were collected from a number of community wells, springs commonly used for drinking water, and surface sources such as rivers, creeks, and lakes. The sites were selected to represent a spatial distribution across the community, different ground water sources, and bodies of water used for different types of activities (fishing, boating, swimming, etc). These tests were conducted in July of 2006.

In the Prairie Band Potawatomi Nation, five surface sites were analyzed. These sites had been previously established by the USGS project to represent water flowing onto and off of the reservation, and spatial distribution (Schmidt, 2004). Results were compared with historical data from these sites for cross-analysis. The tests on the Prairie Band Potawatomi Nation were conducted in early spring of 2007.

The largest limitation that arose with the test kits was an inability to cross-check results. My original sampling plan involved cross-analyzing field results in the University laboratory in the Altai Republic, and the results from PBPN with those from USGS. Once I arrived in the Altai Republic, I discovered that the university laboratory had been closed down and moved to the neighboring region (the Altai Krai). The former employees of the lab theorized that the move represented the beginning of Russia's plan to merge smaller autonomous regions in Siberia into larger ones.

My plan to analyze surface water samples on the same day as the USGS spring 2007 sample was delayed when the EPA was late in approving the PBPN's quality assurance plan. USGS did eventually carry out their spring sampling run, but it was much later than the time period that I gathered my samples, and was also during lower flow, which can affect concentrations of bacteria and other parameters. Instead, I compared my water quality results with historical results from the same sites, which still provided a useful tool for data analysis.

Chapter V

Results

The primary focus of this study was to get a basic idea of the spiritual and cultural importance of water resources to each community, and determine how those attitudes affect their concerns about quality of water resources and their management. These were determined through a combination of interviews and observations in each community. I told informants that their comments would remain anonymous, unless they gave permission to be quoted.

Cultural Traditions

Native Altaian People have developed rich traditions associated with water. Respondents in the Altai Republic provided insight into their spiritual connection with local bodies of water, and their perceptions concerning the quality of local water resources. In the Altai tradition, each body of water has its own master, or spirit, who must be respected. Frequent trips are made to rivers and springs to get water for households, to treat certain ailments, and for spiritual practices. No matter the purpose for which the water will be used, it must be treated with respect and certain protocols must be obeyed. For example, a person should not approach rivers or springs at night, nor should they try to take water at night. They are not to pour anything perceived as “bad” into the water, or throw stones and rocks into the river. These are all perceived as very disrespectful to the spirit of that body of water. When one approaches the water, they are to have a clean mind (no bad thoughts), and should not cry or speak loudly while at the water. As one respondent put it, "when you are in a bad mood you shouldn't go to the river." If any of these protocols are broken, it is believed that the spirit can punish you through drought, illness, and in extreme cases, even death.

An important part of the culture surrounding the proper treatment of water is the placement of "deremar" (деремар) when visiting a spring, river, or any other sacred place. Deremar are pieces of white cloth, usually torn from a piece of white clothing worn to visit the sacred place. These are tied to a tree or other object near the spring or river, and represent that person's prayers and offerings to the spirit of that place. Once the offering is made and all respects are paid, the person may wash their face, drink some water and carry some water away for personal use.

A young Altaian woman who agreed to be interviewed for this project related the story of her first trip to a spring. Her grandmother took her to the spring, near her father's native village. She remembers that her grandmother was very excited, but also very serious. When they arrived at the spring, her grandmother was very respectful as she said a prayer and tied pieces of cloth to a tree. When her grandmother finished her prayers, she washed the young girl's face and head. The young girl, now a young woman, said that the ritual meant her grandmother wished only the best for her, and had asked the spirit of the Altai and the spirit of that place to help her in her life. She related that, since that day she has maintained this attitude towards springs and the belief that any spring has very great power, which gives energy, which in turn gives purity.

There is a persistent belief among Native Altaians, as well as people of European-Russian descent living in the Altai, that springs can cure certain ailments. If a person gets a sore throat, or upset stomach, or any other number of health problems, they are instructed to go to a particular spring and pray, and drink some of the spring water. As stated above, there is a belief that springs and other bodies of water are very powerful, and that if you come respectfully with a clean mind, the spirit of the spring will help you. If a person visits the spring with negative feelings and behaves disrespectfully, they will be punished.

Respondents at the Prairie Band Potawatomi Reservation were less willing to speak about sacred traditions, and it was agreed before any interviews began that they would not be pressed to speak about anything they did not wish to share. Many tribes in North America have experienced more exploitation at the hands of "researchers" relative to Indigenous Siberians, and are understandably wary about revealing details about sacred practices.

One topic that was discussed briefly is that it is important to have "natural," untreated water for many of the ceremonies celebrated by the tribe. People from many different tribes in North America have experienced health problems from using contaminated water in ceremonies and traditional crafts (Holder, 2007). The availability of clean water then becomes both an issue related to both sovereignty and environmental justice. It is important to people living on the PBPN Reservation to have clean surface- and ground-water for safe subsistence practices involving hunting and fishing, as well as to have a water source that is controlled by the tribe to supply water for tribal needs.

Major Sources of Contamination

The importance placed on water resources and the surrounding cultural protocols create an attitude whereby both of these Indigenous communities make efforts to minimize pollution and other forms of ecological damage. However, outside factors have threatened the ecological health of water resources for both the Altaians and the Prairie Band Potawatomi.

The economy of the Altai Republic has seen a needed boost in recent years from tourism. Private car ownership in Russia is increasing (Bush, 2003), making travel to attractive locations such as the Altai more viable. While the region is enjoying the money brought in by tourists, they are also facing a new ecological threat. Interview respondents reported that most of the tourists do not know, nor do they observe, traditional protocols of respect when visiting bodies of water. Springs, rivers and lakes are the most popular destinations for these tourists, with many new shops opening near these bodies of water every year. It was not uncommon to see numerous people camping along the edges of rivers and lakes, often with piles of trash nearby.

My personal observation over three years of travel to the Altai was a noticeable increase in the number of cars, especially newer cars, as well as an increase in the number of motor boats servicing tourists on Lake Teletskoye. A helicopter tour agency was new to the lake in 2005. In addition, many companies in Russia, including the large natural gas company Gazprom, have bought land near the lake to construct tourist resorts.

The impact of this increase in tourist activity is easy to see in the trash people leave scattered around the lake shore. Though there are laws against dumping motor oil, local workers in the camp report that it is common to see boat operators pouring harmful chemicals directly into the lake. Another worker said that it is common to see people using soap to bathe and wash their clothes in the lake. This activity can threaten local aquatic populations, as well as the local human populations who fish and swim in the lake. When asked why people might do this, the camp workers responded that people perceive the lake as so big, a little soap, trash, or motor oil won't cause a problem. There is also a lack of knowledge of the rich Indigenous tradition surrounding the lake. The workers themselves admitted that they don't see the water in Teletskoye as polluted in the slightest (Gorno-Altaisk State University camp staff, 2006, *personal communication*).

Tourists are also threatening the ecological health of the Katun River. The shores of the river are popular camping destinations for many people, but so far the area around Gorno-Altaisk is lacking proper facilities to accommodate the campers. Without proper waste receptacles, people often throw their garbage into the Katun or leave it on the shores of the river. Similar to the situation at Lake Teletskoye, tourists often rinse out their clothes in the river, contaminating the water with detergents and other chemicals (*personal observation*, July 2004-2006). Lack of proper sanitation areas has also presented a problem. The Sanitation Services of the Altai assign workers to clean up after the tourists, but reportedly they do little more than walk along the riverbanks and pick up errant trash (Sanitation Services of the Altai Republic, 2006, *personal communication*). If left unchecked, the pollution from tourists will become a serious threat to the ecological health of the river and its reliant communities.

In the Altai, it is widely believed that spring water can be directly consumed with no worry of becoming ill from contaminants. I did not personally encounter anybody who believed otherwise. The sanitation service representative from the city of Gorno-Altaisk reported that 38 percent of people living in the Altai get their water exclusively from springs and other untreated sources such as wells. Other respondents, when asked about this number, thought that it was probably significantly higher, considering the number of people who live in villages with no access to a central (municipal) water source. It was reported to me, along with my personal observations, that people who live in larger cities with access to a central water source also drink water from springs, often preferentially. The preferential use of springs is attributed to the belief in the health and curative properties of springs, and also to custom. Traditionally, springs were primary sources of drinking water because of the difficulty digging wells in an area that has traditionally had permafrost. In addition, the high mineral content of springs allowed them to remain unfrozen during the winter.

The respectful practices required when interacting with a spring maximizes the likelihood that the water remains pure and uncontaminated. Though Soviet land-management practices discussed in previous sections polluted many of the springs in the Altai, the return to more Indigenous traditional practices has helped them rapidly recover (Malkov, 2004). Unfortunately, the economic problems in the Altai may further compromise local spring water.

Springs are particularly popular with tourists, and are heavily impacted by their activities. The tourists are often unaware of the proper behavior around springs, and were observed littering, urinating near the springs, and filling bottles without a properly reverent attitude (taking the water as a "souvenir"). The foot-traffic around popular springs has removed much of the surrounding vegetation, which may increase the turbidity and possibly the amount of bacteria and other harmful particles in the normally crystal-clear water.

Tourists seem particularly enamored with the idea of "deremar." Many tourists attempt to participate in this tradition by tying their own cloths on trees and other objects around the spring. However, they are unaware of the spiritual traditions associated with deremar, and tie many different colored cloths instead of the traditional white cloth. Because of the number of tourists participating in this tradition, trees around some springs take on a "mummified" appearance. This presents an additional ecological threat by reducing vegetative cover and increasing pollution in the springs when the cloth ties come undone and fall into the water. At least one respondent felt that it is disrespectful for a person who is not of their tradition to tie a cloth at a sacred place, and believes there is no point in their doing so without understanding the surrounding traditions. The situation has reportedly improved somewhat with the placement of signs in popular tourist areas, which explain the tradition and ask the tourists not to tie their own pieces of cloth there.

Other reported threats to water quality in the Altai Republic are non-point polluters such as agricultural runoff, and point-source polluters such as wastewater treatment plants. One respondent from GASU reported that in regions lacking a wastewater treatment plant, the common practice is to put the wastewater onto fields to let it decompose. This is a common practice in many regions of the world that does not present an ecological threat if handled properly. Riparian zones are important in filtering this type of runoff before it contaminates areas of surface water such as springs and rivers. Management of this specific practice was not examined for this study; however this is an area of possible future research.

The major threats to water quality on the Prairie Band Potawatomi Reservation are bad farming practices and non-point source pollution from overland runoff. Largely as a result of land and property reorganization under the Dawes Act in 1887, which granted the largest land holdings for farming and the second largest for raising cattle, approximately 90 percent of Reservation land is either agricultural or pastoral (Schmidt, Mehl, & Pope, 2007, fig. 2). Most streams and rivers in the Midwestern United States face the same problem – nutrient, bacterial, and chemical pesticide pollution from overland runoff ("Riparian," 2006). The Prairie Band Potawatomi Office of Land Management has taken steps to help alleviate this type of pollution, including transitioning to no-till farming in recent years (Daniel Dyer, 2005, *personal communication*). No-till farming is a way of growing crops from year to year without disturbing the soil through tillage, and has been shown to have numerous benefits, including reducing erosion and agricultural runoff (Huggins and Reganold, 2008). They have also planted riparian zones to create a filter between tilled fields and surface-water streams, as well as implemented a stream-bank stabilization project, both of which will reduce the amount of harmful contaminants entering local streams (Daniel dyer, 2005; Carl Matousek, 2007, *personal communication*).

Ground-water sources on the Reservation are relatively unpolluted, but may be threatened by old hand-dug domestic supply wells, which act as conduits for fecal coliform bacteria and other types of contamination to pollute areas of the water table. It was reported that some people living on the Reservation still use wells for a household water supply, though no one could quantify the number of people. All respondents thought it was at most only a few families currently using well water instead of the municipal water supply. It was also reported that the Native American Church (NAC) had preferentially been relying on well-water. When one of the members became ill, the water was tested by the Office of Planning and Environmental Protection (OPEP), showing the well was contaminated with fecal coliform bacteria. The church consequently began using the municipal water source for water involved in ceremonies (Sharon Bosse, 2007, *personal communication*).

As part of its attempts to establish sovereign control of their land and water, the Prairie Band Potawatomi Nation is continuing to pursue water-quality standards and a municipal water supply controlled by the tribe. If the tribe succeeds in developing an autonomous municipal source, ground-water resources on the Reservation will supply the majority of the water for municipal use by the tribal members. The tribe had anticipated using the results of the USGS study (Schmidt, Mehl, and Pope, 2007. See Appendix 1) to identify adequate water resources for the Nation and develop their own Reverse Osmosis Plant to treat the ground water and provide clean water to the Reservation.[7]

In April of 2008, the tribe participated in talks with the Kansas Rural Water Association to discuss water-supply alternatives. During those talks it was recognized that the water lines currently serving customers on the Reservation are owned by RWD #3 and that the tribe must purchase those lines or install new ones to provide water to the community. The cost of purchasing the RWD lines or constructing new ones, combined with the cost of constructing wells and a water treatment plant, have proved too great to move forward with the project at this time.[8]

[7] For more information, see http://www.pbpindiantribe.com/proj-reverse-osmosis-plant.aspx.
[8] For more information, see http://www.krwa.net/ops/letters/080407PotawatomiBand.pdf.

Community-Based Water-Quality Monitoring

Through these observations and interviews, it has been demonstrated that the people of both the Altai Republic and the Prairie Band Potawatomi Reservation are facing pollution issues with their water resources that may threaten drinking-water supplies, aquatic ecosystems, and in consequence traditional Indigenous ceremonies and subsistence lifeways. It is important to present solutions to these problems that are within the context of each culture and do not conflict with traditional protocols. I and my colleagues have suggested a community-based water-quality monitoring program as one solution. We believe that this type of program will serve to increase awareness in each community concerning possible risks associated with water resources, which are especially important in resources used for drinking water.

In the Altai Republic, respondents felt that the LaMotte GREEN Test Kits could be used to test springs, rivers, lakes, and groundwater, and that if used properly, would not conflict with traditional protocols of respect. All respondents felt that they would be useful in monitoring areas impacted by tourists. However, when asked about the possibility of people using them to test spring water before they consumed it, the general consensus was that most villagers would not be willing to do so. As mentioned previously, there is a belief that spring water is pure and that consumption poses no health risks. If the Altaians see no reason to test the water, they are not likely to use the test kits very regularly, if at all.

Respondents at the Prairie Band Potawatomi Reservation also felt that the test kits would be useful in monitoring surface- and ground-water sources, especially surface-water sources used for hunting and fishing, and wells that are still used for domestic supply. People on the Reservation responded more positively than the Altaian People to the possibility of using the test kits regularly to monitor the health and safety of the water resources. They seemed particularly excited at the idea of introducing the test kits into schools and training their youth to test the water.

Responses from the Altaian People and the Prairie Band Potawatomi indicate that information dissemination is a major factor in the willingness of people to use test kits. It was common to hear people in the Altai express the opinion that all water resources were clean, and posed no health risks. The Sanitation Services of the Altai reported that no one ever gets sick from water-borne illness. This could indicate that there are minimal contaminants in any of the local springs, or, what is more likely, that water-borne illnesses do not get diagnosed correctly. From my observations and interviews, I would conclude that the latter is true.

Despite such official claims, however, respondents from Gorno-Altaisk State University (GASU) seemed to confirm the latter theory, saying that there was no effort to find a correlation between contaminated water and illnesses. One respondent from the University who attended the meeting with the Sanitation Services described the information they provided as "well-filtered," and pointed out that they could provide statistics about how many people had suffered from a particular ailment, but they weren't allowed to provide information about the certain location where the illnesses had taken place. He later clarified, saying that information from the Sanitation Service was accurate, but not complete. Successful implementation of a community-based water-quality monitoring program could be a way to inform the Altaian People of the status of their water resources, as well as a way to empower the community instead of relying on outside agencies for information.

The Office of Planning and Environmental Protection (OPEP) for the Prairie Band Potawatomi Nation reported that there are widely available resources for people who wish to have their wells, ponds, or other sources of water tested. If a resident reports a problem to OPEP, the Nation will pay for tests to be performed. Information about water quality on the Reservation is frequently published and disseminated. Prime examples are the reports prepared by the USGS reporting the results of their 10-year study on the Reservation. These reports are widely available in print, as well as on the web.[9]

Test Kit Results

The test kits which are the focus of the community-based water-quality monitoring program (LaMotte GREEN Test Kits) were used to perform tests on water resources, both in the Altai Republic and the Prairie Band Potawatomi Reservation. Tests were performed independently by the researcher, and with groups of children from local camps and youth centers. Results for spring water in the Altai were relatively consistent – no nutrient contamination, low to no turbidity, good dissolved oxygen content, normal pH. Occasionally, fecal coliform bacteria were detected, most notably in the sacred spring in the city of Gorno-Altaisk.

This spring is very popular among people in living in the town. The other spring to test positive for fecal coliform bacteria was "Holy Spring," near Lake Teletskoye.

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[9] Reports available at http://pubs.usgs.gov/sir/2007/5201/pdf/sir20075201.pdf.

When the research group was conducting tests at this particular spring, we were joined by four young children filling up plastic jugs for domestic use. Fecal coliform bacteria are general indicators of the presence of bacteria, which may or may not include harmful bacteria such as *E. coli*.

The test kits were used to test the water supply at Camp Manzherok, with a large group of children. The children seemed very excited about using the kits. They asked if we could test the camp water supply, then asked if we could test their swimming lake. The children were able to perform the tests with assistance, and were able to accurately read the results. The camp water supply tested negative for all constituents. In contrast, the lake used for swimming and for cooling off after using the banya tested positive for nutrients (nitrate and phosphate). Fecal coliform bacteria was not tested in the lake, as we had a limited number of tests and the lake was only tested on the children's request, and was not part of the original sampling plan.

Test kit results for Prairie Band Potawatomi were consistent with the test results from the USGS study. Surface water sources were turbid, and tested positive for both nutrients (which nutrients) and fecal coliform bacteria. This is relatively normal (though not healthy) for streams in Kansas that run through agricultural lands.

Ground-water was not available to be tested with the test kits, but was tested by USGS. The ground-water available on the Reservation is relatively free of contaminants, with the exception of a couple of wells. It has not been determined conclusively what is contaminating certain areas, but it is suspected that nearby hand-dug wells are acting as conduits for soil and contamination to pollute the water-table.[10]

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[10] Full results of USGS testing are available in Schmidt, Mehl, and Pope, 2007, and on the Web at: http://pubs.usgs.gov/sir/2007/5201/pdf/sir20075201.pdf.

Children from the Potawatomi Boys and Girls Club participated in one round of testing on the Reservation. They too seemed very excited about performing the tests. They were able to use the kits with assistance, and to read the results. When the testing was finished, the children inadvertently demonstrated the need for monitoring surface-water quality by diving into the stream for a swim. For activities such as swimming when a certain amount of water may be ingested, the USEPA allows no more than 298 colonies of *E. coli*, or 78 colonies of *Enterococci* bacteria, per 100 milliliters of water. The test kits yielded a positive result for fecal coliform bacteria, and results of the USGS tests showed concentrations in the stream water on the Reservation greatly exceeding the USEPA guideline for primary contact recreation.[11]

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[11] See Table 16 in Schmidt, Mehl, and Pope, 2007.

Chapter VI

Conclusion

The availability of clean water has become a problem of international concern. Without drastic action, the problem will only get worse. Many communities around the world suffer from the effects of contaminated water resources, or the lack of adequate water resources and sanitation. Often, it is the poorer communities who feel the greatest negative effects of polluted water resources and other environmental justice issues. Indigenous communities have a higher likelihood of monetary poverty, and thus are often more greatly affected by environmental problems than their non-Indigenous counterparts. Health problems from polluted water sources are exacerbated by the relative lack of health care in many Indigenous communities. This international problem must be addressed quickly, to prevent further avoidable epidemics of death and disease.

This study gathered information from two Indigenous communities through research, interviews and water-quality tests, in order to show the health effects of polluted water resources on Indigenous communities, to determine the water quality issues facing each community, and to lay a framework for future preventative measures. It was determined that both the Altaian People and the Prairie Band Potawatomi Nation are facing important water quality issues that will need to be addressed by current and future generations.

The information obtained in this research will be used to help design a sustainable program for each community that works within the unique needs and culturally imposed constraints of Indigenous Peoples in different parts of the world. This framework is not meant to be a final solution to the serious issues involved in water quality, nor will it represent a solution for all Indigenous cultures. Following steps to implement such a program include disseminating LaMotte GREEN test kits to each community, and designing a program through which to implement them effectively. This program must be guided by the cultural and scientific information presented in this study, in order to operate within cultural constraints, address appropriate problems in a feasible manner, and encourage the greatest possible participation and longevity for the program. A possible route of introduction for such a program is through local schools in each community, to teach younger generations about possible health problems associated with drinking water and employ the ability of children to excite entire families and communities about an issue.

In the Altai Republic, it will be crucial to have the participation of Altaian elders in the youth program. The water testing protocols should be taught alongside cultural protocols, in order to avoid any perceived conflicts between the traditional regard for water and the use of the test kits. A similar approach should be taken with the Prairie Band Potawatomi youth, to encourage the teaching of cultural practices alongside the scientific practices. In both cases, involving elders will ensure that the community is involved and will help the program to succeed.

The pollution issues affecting water resources influence all communities, rich and poor, Indigenous and non-Indigenous. We must all work together to discover solutions and prevent the further contamination of our water resources. This study will be one small step in improving community health and empowering Indigenous People, by ensuring they have the technology to determine the status of their own water supplies.

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Appendix I

The USGS publication "Water quality on the Prairie Band Potawatomi Reservation, northeastern Kansas, June 1996 through August 2006" (U.S. Geological Survey Scientific Investigations Report 2007–5201) was co-authored by the author of this thesis, and is submitted as an appendix to the final Master's Thesis. The report is available online at: http://pubs.usgs.gov/sir/2007/5201/pdf/sir20075201.pdf.